Forest Health Protection

Pacific Southwest Region
Northeastern California Shared Service Area

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To: District Ranger, Beckwourth Ranger District, Plumas National Forest

Subject: Considerations for fire-injured tree harvest and hazard tree abatement within the 2019 Walker Fire, Plumas National Forest (FHP Report NE19-06)

At the request of Kristen Winford, Silviculturist, Beckwourth Ranger District, Danny Cluck, Forest Health Protection (FHP) Entomologist, visited the Walker Fire on November 7, 2019. The objective of this visit was to evaluate the levels of fire injury to conifers, note any insect activity and discuss variables that should be considered when developing fire-injured tree and hazard tree marking guidelines. Recommendations provided in this report will assist in the formulation of silvicultural prescriptions aimed at removing a portion of the fire-injured trees including the abatement of roadside hazard trees.

Key points

Observations were made at three locations representing different vegetation burn severities and forest types. One location was visited on the west side of the fire area on October 29, 2019.

- No insect activity was observed on any burned tree during two site visits but some red turpentine beetle activity in pine was reported by District foresters in some areas.
- The fire burned after the peak flight period for many wood boring beetle species delaying potential infestation of fire-killed trees until spring 2020.
- Bark beetle-caused tree mortality within and adjacent to the Walker Fire area was very low in 2018 and 2019 as mapped by the Aerial Detection Survey.
- Low levels of bark beetle activity pre-fire and wood boring beetle post-fire will likely provide an extended opportunity to capture economic value of fire-injured trees before significant degrade occurs.
- Consideration of Probability of Mortality levels for selecting trees for removal should account for Designation by Damage tree selection and operators potential limited ability to observe insect activity on individual trees from harvest equipment.
- Depending on timing of each activity, there could be inconsistencies with cruising yellow

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pine with pre-bud break guidelines and subsequent harvesting with post-bud break guidelines.

- A portion of the true fir that are within striking distance of a road will likely meet the 1/3 cambium kill criteria, indicating high failure potential, as outlined in the R5 hazard tree guidelines (Angwin et al 2012). Most trees that meet this guideline are those that had excessive course woody debris, especially large logs, consumed at their base.

Description of the project area

The 54,608-acre Walker Fire located 11 miles east of Taylorsville, CA, started on September 4, 2019 and was contained September 26, 2019 (40.1082432N and 120.593729E). The elevation ranges from 3,700 – 7,000 feet with annual precipitation ranging between 20 and 35 inches. Existing forest type at the southwest end and at upper elevations is predominantly Sierra Nevada mixed conifer with ponderosa pine (*Pinus ponderosa*), Jeffrey pine (*Pinus jeffreyi*), Douglas-fir (*Psuedotsuga menziesii*), sugar pine (*Pinus lambertiana*), incense cedar (*Calocedrus decurrens*), white fir (*Abies concolor*) and black oak (*Quercus kelloggii*) (Figure 1). Northeastern areas of the fire are primarily eastside pine (ponderosa and Jeffrey pine) occasionally mixing with western juniper (*Juniperus occidentalis*).

Figure 1. Sugar pine with severe crown kill in a mixed conifer stand, Walker Fire 2019.

Pre-fire bark beetle activity

The level of bark beetle activity occurring prior to a wildland fire can influence post-fire tree mortality. Having many bark beetles available to attack fire-injured trees can lead to higher levels of tree mortality than otherwise expected.

Forest Health Protection aerial detection surveys mapped very little tree mortality within and adjacent to the Walker Fire area in 2018 and 2019. Only a few areas of fir engraver beetle (*Scolytus ventralis*) killed white fir were noted to the west and south.

Post-fire bark and woodboring beetle activity

The amount of post-fire beetle activity and resulting tree mortality depends on many factors such as the timing of the fire, the level of insect activity in the area prior to the fire and stand characteristics. Fire-injured trees are stressed trees and the available soil moisture (pre- and post-fire) can also play a significant role in post-fire mortality. For the Walker Fire, most bark beetle activity in fire-injured trees will begin in the spring of 2020. However, low bark beetle activity leading up to the fire should result in fewer attacked trees at least for the first year. Bark beetle numbers could subsequently increase within fire-injured trees resulting in additional mortality in the second and third post-fire years.

The level of fire-injury on an individual tree plays a role in post-fire insect activity. Fire-injured trees can be placed into three categories: 1) those killed outright or injured so severely that they will soon die, 2) those that are lightly injured and should survive, and 3) those in between, the moderately injured trees. Bark beetles may attack trees in all three categories, but successful brood production will only occur in trees with moist cambium. Trees in category one typically do not have enough moist cambium after the fire or if they do, it will become either resin soaked or dry out before beetles can complete their development. Bark beetles attack these types of trees at lower rates and also experience extreme competition from woodboring beetle larvae, reducing reproductive success. Trees in category two provide the highest level of suitable cambium for bark beetles but typically are not injured to the extent that their defenses are compromised. These trees still have the ability to pitch out beetles as they attack, or more often, are avoided by bark beetles altogether. The highest level of bark beetle attacks are likely to occur on trees in category three, the moderately injured trees. These trees will have moderate to high levels of crown scorch and basal cambium injury that compromise their defense systems, putting them at a higher probability of mortality. These trees provide ideal habitat for bark beetles for several years post-fire. Although fire-injured trees can continue to be attacked within the fire perimeter for several years, bark beetles are not likely to build up and attack adjacent unburned stands. This type of activity has rarely been observed in California and only on very local and small scales.

The level of woodboring beetle activity in fire-killed trees will not be known until spring/summer 2020 as the late start date for this fire occurred after the peak flight period for most species. Woodboring beetles are likely to attack and successfully reproduce in both moderate and severely fire-injured trees as well as trees killed outright by the fire. Trees that had crowns completely consumed (blackened) are typically the first to be attacked, some within days of the fire (Figure 2). Wood borers will also attack trees that had crowns completely scorched but not consumed (red needles remaining) but initially at a lower intensity than blackened trees. Wood borers are not a threat to healthy trees within or adjacent to the burned areas.

Figure 2. High severity patch in mixed conifer stand, Walker Fire 2019.

The level of wood borer activity and the amount of deterioration to trees designated for harvest can also vary by tree species and size, timing of fire-injury, and by geographic location. For example, among the fires of 2012, the Reading Fire (Lassen NF) had extremely high levels of wood borer activity and associated deterioration of harvest trees one year post-fire while the Barry Point Fire (Modoc NF) and the Chips Fire (Lassen/Plumas NF) had significantly less activity and deterioration over the same timeframe. All of these fires burned in late-July through August. The Reading Fire burned near the 2009 Sugarloaf fire (11,269 acres), which may be a partial explanation for the high level of wood borer activity observed within the first post-fire year. The results of a recent post-fire woodboring beetle study suggests that fires with late season ignition dates will have consistently lower woodboring beetle activity over time compared to fires with mid-season ignition dates (Ray et al 2019). This same study also found more woodborer activity in smaller diameter trees and in pine species.

Economic Losses and Potential Hazards Caused by Staining and Decay Fungi

Figure 3. Woodboring beetle galleries (holes in sapwood) and blue stain.

Significant degrade and value losses are highly likely if fire-injured trees proposed for harvest are not removed promptly. Nearly all of the beetles previously discussed carry spores of staining and/or decay fungi that immediately begin to invade sapwood (Figure 3). Blue stain, although not a source of structural degrade, can dramatically reduce the economic value of pine species. Blue stain spreads rapidly into the sapwood and by the end of one year can typically be found in nearly all dead and dying pines. A FHP monitoring study (Eglitis 2006) of 84 fire-killed ponderosa pines in central Oregon found blue stain in 100% of the first 16.5 foot bole sections and in 58% of the second 16.5 foot sections of sampled trees one year post-fire. At the end of two years, 92% of sampled trees had blue stain throughout the entire bole. The occurrence of blue stain within the Walker Fire is not likely to increase significantly until temperatures warm again next spring/summer and additional bark and wood-boring beetle activity carries staining fungi to more trees. Decay fungi that are introduced typically do not cause significant degrade until after the first post-fire year, with smaller diameter trees decaying faster than large diameter trees.

Figure 4. Green fire-injured white fir failure five years post-fire.

Sapwood decay can create significant tree hazards in addition to a reduction in economic value. This is particularly true for fire-injured true fir, as surviving trees that develop extensive sapwood decay over the next few years could present hazards to the road system and crews working in burned stands. Previous FHP monitoring of fire-injured trees revealed the failure of 8" to 24" dbh red and white fir, with green crowns, in as little as three years (Figure 4) (Report: SPR-07-05). The rate of failure increased dramatically after the fourth year, especially in conjunction with high winds or heavy snows. This type of post-fire tree failure was observed in the 1999 Bucks Fire (Plumas NF), 2001 Star Fire (Tahoe NF) and the 2000 Storrie Fire (Lassen NF).

Fire-injured tree marking guidelines

The guidelines developed by Region 5 FHP, *Marking guidelines for fire-injured trees in California* (Smith and Cluck 2011) are appropriate for use in the Walker Fire. The following factors should be considered when selecting the probability of mortality(s) for tree removal:

- the need to expedite tree harvest to capture economic value before significant deterioration and degrade occurs

- the need to reduce the number of fire-injured trees along roadsides that have a high probability of mortality
- the need to use "Designation by Damage" to minimize the tree marking, having operators choose trees for removal
- the need to meet post-fire fuels objectives
- the need to meet post-fire wildlife objectives
- the need to meet reforestation objectives

The crown scorch guideline for yellow pine (pre-bud break) should be used to mark ponderosa and Jeffrey pine at this time. If tree marking continues next spring/summer, the crown kill guideline for yellow pine (post-bud break) should be used as soon as new growth is clearly visible throughout the crown. The red turpentine beetle guideline is also not recommended until bud-break in June 2020 if it is determined that red turpentine beetle activity is occurring throughout proposed harvest areas at that time (FHP can help with this determination). Cambium sampling is not recommended due to limited increases in guideline accuracy relative to the large amount of time required to perform inspections on individual trees. The exception would be for true fir roadside hazard tree assessments where some sampling would be required to determine extent of cambium kill.

Something the District should be aware of using DxD, depending on the timing of stand cruising relative to tree harvest, is that the guideline used for yellow pine may switch from the pre-bud break (if cruising is accomplished before bud break 2020) to the post-bud break (if harvest occurs after bud break 2020). Although both guidelines provide a high degree accuracy in predicting mortality, they are evaluating different crown characteristics and there may be a few discrepancies at the individual tree level between what was estimated to be removed versus what is removed. For example, a tree with >90% crown scorch pre-bud break may have live crown (buds surviving) of greater than 40% post-bud break. This tree may meet the pre-bud break guideline but not the post-bud break guideline. These discrepancies will likely be very infrequent relative to the large number of trees cruised in the project area and only pertain to fire-injured ponderosa and Jeffrey pine with some remaining green crown.

The models used to develop the fire-injured tree guidelines were based on the tree size ranges listed in the marking guideline tables. For some species, such as yellow pine and white fir, the amount of crown injury required to meet a chosen Pm decreases as diameter increases. Therefore, it is possible that trees that are larger than the range of those used to develop the guidelines may require even less crown injury to meet a chosen Pm. However, since the models did not include these larger trees, a more conservative approach is warranted. For trees in the Walker Fire that are larger than those listed in the tables, the district should use the guidelines for the largest listed diameter class. For example, a 55" DBH ponderosa pine would use the guideline for a >40"-50" ponderosa pine (yellow pine).

Potential guideline alternatives:

1) *Only mark and remove trees with no green needles* - This will insure that no tree will be removed that may have otherwise survived its fire-injuries. This will also result in a large number of trees remaining on the landscape that will ultimately die from fire-injury and subsequent bark beetle attack. These dead trees may have to be felled and/or removed at a

future date, at high cost, to facilitate tree planting, reduce large woody fuel loading and/or mitigate tree hazards.

2) *Mark all trees in salvage units at the Pm=0.7 level* – Under the current conditions of normal precipitation and background levels of bark beetle-caused tree mortality, this is a reasonable approach to meet post-fire objectives within salvage units. Especially if the ability to harvest additional trees as they die (trees that didn't initially meet the mortality threshold) is built into sale contracts.

3) *Mark all fire-injured roadside trees at the Pm=0.5 level* – Marking fire-injured trees at a lower Pm level along roadsides is highly recommended to reduce the number of additional hazard trees that will need to be abated as a result of delayed mortality. Having to return to road segments annually to remove additional mortality will likely be time consuming and cost prohibitive and not meet post-fire objectives of restoring safe travel corridors.

4) *Mark all trees at a slightly lower Pm level to compensate for potential problems with observing significant woodboring and bark beetle activity using Designation x Damage* – This alternative may be useful if marking crews are not available to pick out and mark these types of trees ahead of DxD operation. Harvest equipment operators may not be able to see woodboring beetle frass and boring dust, woodpecker activity and/or bark beetle pitch tubes that meet guideline criteria. Lowering the probably of mortality may be a way to compensate for the inability to identify infested trees that might otherwise be left in treatment areas. However, added volume provisions in contracts may be adequate to capture these types of trees as they fade over time.

Hazard tree marking guidelines

Region 5 FHP hazard tree guidelines (Angwin et al 2012) define failure and target potential to help land managers make more informed decisions for hazard tree abatement projects. In using these guidelines for roadside hazards, the district will need to decide which trees need to be removed based on the failure potential rating of any defect(s) found (including fire-injuries) and the "Exposure Duration" (Long, Short or Intermittent With High Frequency), which reflects such factors as road maintenance level, traffic volume, and degree to which people stop and congregate.

Please keep in mind that the FHP hazard tree and fire-injured tree guidelines are addressing different subjects. The fire-injured tree marking guidelines are predicting tree mortality, not failure potential. The hazard tree guidelines predict tree failure potential, not tree mortality. Both can be used along roadsides to abate existing tree hazards due to defect and remove trees that are likely to die from fire injuries and pose a hazard in the near future. Both guidelines have been provided to the Beckwourth Ranger District.

Based on past observations of fire-injured true fir failure, the District should consider using the hazard tree guideline addressing cambium kill for white and red fir along roadsides. This requires periodic sampling of cambium with a hatchet to determine if deep charring indicates cambium kill. True fir with deep charring over more than 1/3 of the bole circumference, when the relationship between deep char and cambial mortality has been confirmed, indicate a high failure potential.

Treatment of cut stumps to prevent Heterobasidion root disease

Fresh cut stumps of fire-injured trees can provide entry courts for Heterobasidion root disease (*Heterobasidion occidentale and H. irregulare*). Stumps of trees killed by fire that have been dead less than 18 months should also be considered susceptible. Therefore, it is recommended that a registered borate compound be applied to all freshly cut conifer stumps >14" dbh in order to reduce the chance of new Heterobasidion root disease centers being created through harvest activity. However, treatment of stumps may not be as beneficial in high severity harvest areas where no green trees remain.

If you have any questions regarding this report and/or need additional information please contact Danny Cluck at 530-252-6431.

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